MONTHLY WEATHER REVIEW

Editor, ALFRED J. HENRY

VOL. 59, No. 5
W. B. No. 1048

MAY, 1931

CLOSED JULY 3, 1931
ISSUED AUGUST 10, 1931

TWO SERIES OF ABNORMAL WINTERS

By THOMAS ARTHUR BLAIR

[Weather Bureau, Lincoln, Nebr., March 11, 1931]

In the middle Missouri Valley and adjacent portions of the Great Plains and of the Mississippi Valley, there was a remarkable series of six consecutive cold winters (December to February, inclusive), from that of 1882–83 to that of 1887–88. In the same region a series of six consecutive warm winters occurred from 1918–19 to 1923–24, inclusive. These persistent tendencies of six years' duration are clearly shown in Figure 1, in which are plotted the accumulated sums of departures of the winter temperatures, for the States of Nebraska and Kansas and for the cities of Des Moines and Huron.

The continuance of such abnormalities through successive winters suggests the persistence of important pressure anomalies. If the average pressure deviations of the six cold winters be entered on one chart, and those of the six warm winters on another, the "accidental" variations of the individual years will be largely eliminated, and the resulting maps should show some of the larger characteristics common to the winters of either series, and perhaps give some additional information about the nature of those pressure oscillations and correlations with which Hildebrandsson, the Lockyers, Walker, and others have dealt so extensively. In Figures 2–9 an attempt has been made to draw such charts for the entire globe and for departures of temperature and precipitation as well as those of pressure. The data were taken from World Weather Records (1). It is recognized that they are very inadequate in many parts of the world, especially for the years after 1920. Many irregularities of the curves are doubtless thus omitted and some large areas perhaps improperly represented, but the main features of the various distributions, especially in the Northern Hemisphere, are unmistakably shown.

Winter-pressure deviations.—Figure 2 shows the departures from normal pressure for the months of December, January, and February for the period of six years, beginning with December, 1882, and ending with February, 1888, here called the cold winters of 1883–1888, and Figure 3 similarly for the warm winters of 1919–1924. A general reversal of pressure departures in roughly latitudinal belts is the most evident feature of these charts. The reversal is practically complete in the Northern Hemisphere but doubtful in the Southern Hemisphere. In the cold winters, a band of subnormal pressure surrounding the globe and centering at about the Tropic of Cancer but with extensions into the southern oceans, separates belts of above normal pressure in higher latitudes, both north and south. In the warm winters the central belt is one of high pressure in about the same latitude with southward extensions over the oceans and there is a complete north polar belt of low pressure. The southern belt of low pressure appears to be incomplete, accepting the positive departure at the South Orkneys, based on a short record, as representative of Antarctic regions.

The charts show a weakening of the tropical high-pressure belt in the Northern Hemisphere in the cold winters, and a strengthening in the warm winters, with corresponding increases and decreases, respectively, of pressure in north polar regions. The well-known contrast between Iceland and the Azores is strongly shown in Figure 3, but is weak in Figure 2. On the other hand

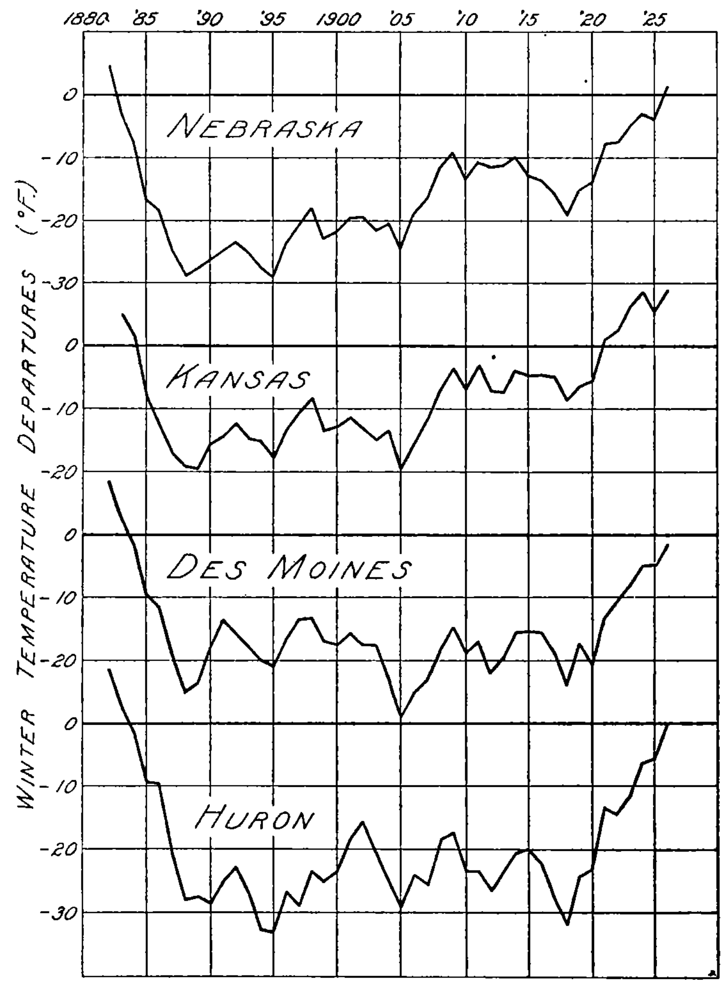

FIGURE 1.—Accumulated sums of departures of winter temperature for Kansas and Nebraska and Des Moines, Iowa, and Huron, S. Dak.

the opposition between Honolulu and Alaska is well developed in the cold winters but not in the warm winters. The departures at Honolulu, northwest India, and south Australia, are of the same sign in each case, as found by Walker (2) for the months of December to February.

Summer-pressure deviations.—In Figures 4 and 5 are represented the average pressure departures six months earlier each year; that is, for June to August, 1882–1887 and 1918–1923. We see that the pressure distributions of June to August are recognizably related to those of December to February, in the corresponding years. The belts of deficient pressure in Figures 2 and 4 have the same general character, and many of the irregularities of the boundaries maintain their identity, though shifted somewhat in position. For example, the two northward tongues from the southern high-pressure area in Figure 4 persist six months later in Figure 2, and the well-marked deficiency separating them appears in both maps. In Figures 3 and 5 the similarity is less striking, and the central girdle of high pressure has shifted from the Southern Hemisphere in the southern winter to the Northern Hemisphere in the northern winter.

The most notable change from summer to winter is the complete reversal of pressure departures in the north Pacific in both series of years. For June to August, 1882–1887, pressure is above normal in practically the entire Pacific Ocean north of the Equator; six months later it is all below normal. The same complete change but in the opposite direction occurs from summer to winter in the years 1918–1923. No other large area shows such a complete reversal in both series of years.

Walker (**2**) found for June to August a strong positive correlation of pressure departures in South America, represented by Buenos Aires, Cordoba, and Santiago, with departures at Honolulu and Samoa, and negative correlation with northwest India, east Australia, and Mauritius. This "southern oscillation" is not consistently shown in the years here under discussion. In the first place, it would seem better to consider the east and west coasts of South America separately, since the departures at Buenos Aires and Santiago are of opposite sign both winter and summer from 1918–1924. There are other inconsistencies; in Figure 4 the relation of South America, as used by Walker, is negative with Honolulu and positive with northwest India; in Figure 5 deviations at Honolulu and Samoa are of opposite sign.

It may be noted that during the summers preceding the cold winters of 1883–1888 in the United States, pressure was high across the north Pacific, and preceding the warm winters, 1919–1924, it was low. This agrees with the result previously obtained (**3**) from a different group of years, consisting of eight warm and eight cold winters.

Temperature distribution.—The temperature departures, December to February, are shown in Figures 6 and 7. For the most part they may be inferred roughly but not in detail from the contemporary pressure anomalies. The northern area of excess pressure in the cold winters, 1883–1888, with centers over Manitoba and the Caucasus, was attended by subnormal temperature over the entire United States except Florida and the Pacific northwest, over most of Canada, and over Greenland, Iceland, western and southern Europe, and southern Asia, and by warm weather over northern Europe and Asia. It was also cold in central South America, northwest of the center of positive-pressure departure off the southeast coast. From 1919–1924 the winters averaged more than 2° F. warmer than normal in a large part of central North America from St. Louis to Eagle, and in nearly all of Europe, in conformity with the marked deficiency of pressure throughout northern latitudes. The reason for the cold area in the vicinity of Newfoundland is not apparent.

In Figure 7 the remarkable feature is the great preponderance of warm weather over all continental areas except Australia. It appears that a combination of all temperature records obtained would indicate that the world was definitely warmer than normal during this period, made up of the same three months in six successive years. Possibly the result would be different if data were evenly distributed over the entire surface of the globe.

Distribution of precipitation.—The distribution of precipitation in percentages of the normal is shown in Figures 8 and 9. For the most part, areas in which pressure, December to February, was above normal were areas of light contemporary rainfall, and those in which the pressure was below normal had more than average rainfall, but the related areas are far from coinciding exactly. In the United States there appears also a negative correlation between precipitation and temperature in both sets of years. The cold winters were wet and the warm winters were dry except in the southern plains region. It has recently been shown in greater detail (**4**) that this inverse relation prevails over a large part of the United States when all winters with temperature departures of 2° F. or more are considered, but that in other areas, including a portion of the southern plains, the relation is more frequently direct.

Both series of years were abnormally wet in Mexico, showing no relation to shifting pressure belts. Temperate South America shows a reversal of precipitation conditions from one series of years to the other more definite than its pressure changes. In Australia there is negative correlation between temperature and precipitation, as in the United States, and an alternation of conditions between northern and southern portions. From 1883–1888 there were dry and warm summers in the south and wet and cool at Port Darwin; from 1919–1924 it was wet and cool in the south and dry and warm in the north.

General remarks.—The cold years of 1884–1886 are connected by Humphreys (**5**) with the great volcanic eruptions of Krakatao, August 27, 1883, and Tarawera, June 10, 1886. This does not account for the fact that the cold began in the winter of 1882–1883; nor does volcanism account for the persistent warm period.

These warm and cold winters fit fairly well into the theory of the influence of sun-spot numbers upon world temperatures, and the periods are approximately one-half the 11-year sun-spot cycle. There was a maximum of sun spots in January, 1884, in the midst of the cold years but the numbers decreased rapidly in 1886 and 1887, while the temperature deficiencies continued into the spring of 1888. The warm period, 1918–1924, which prevailed in all continents except Australia, was a period of continuously decreasing sun spots, reaching a minimum in January, 1924. There was not, however, a very definite termination of the warm period in the Missouri Valley in 1924. After a slight downward tendency in the winter of 1924–25, the curve again moved rapidly upward. The sun-spot maximum of 1893 was followed by three cold winters as shown in Figure 1, and the minimum of 1913 by two or three warm winters, but in these cases, though the extremes of sun-spot numbers were more pronounced than in 1884 and 1924, the temperature changes in north-central America were neither so marked nor so prolonged.

Whatever the causes may have been, these maps show large areas of reversed pressure anomalies and a definite "change of climate" in one of these sets of years as compared with the other. The pressure deviations were not mere statistical abstractions, but were attended by real and important differences of temperature and precipitation over large areas. At Winnipeg the later series of years averaged 12.7° F. warmer than the earlier and over a large portion of Canada and the northern United States

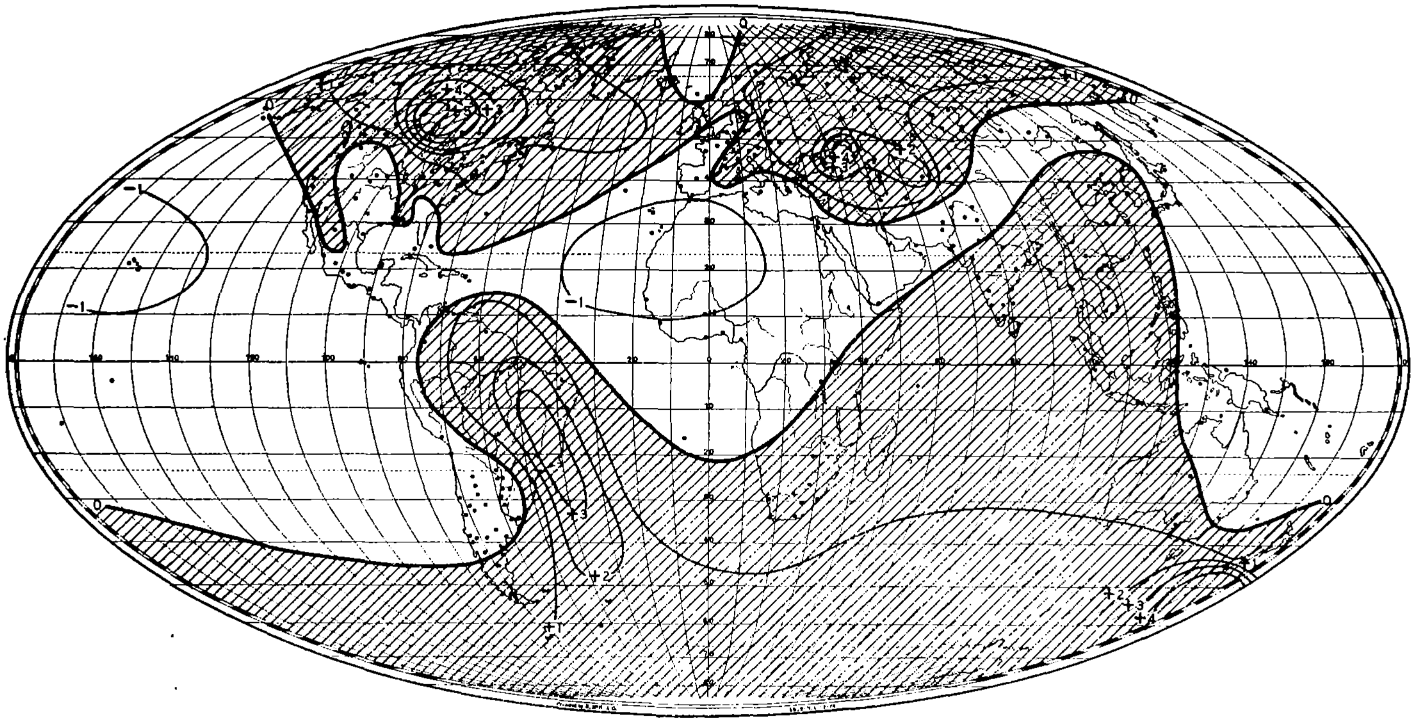

FIGURE 2.—Pressure departures, millibars; cold winters, 1883–1888

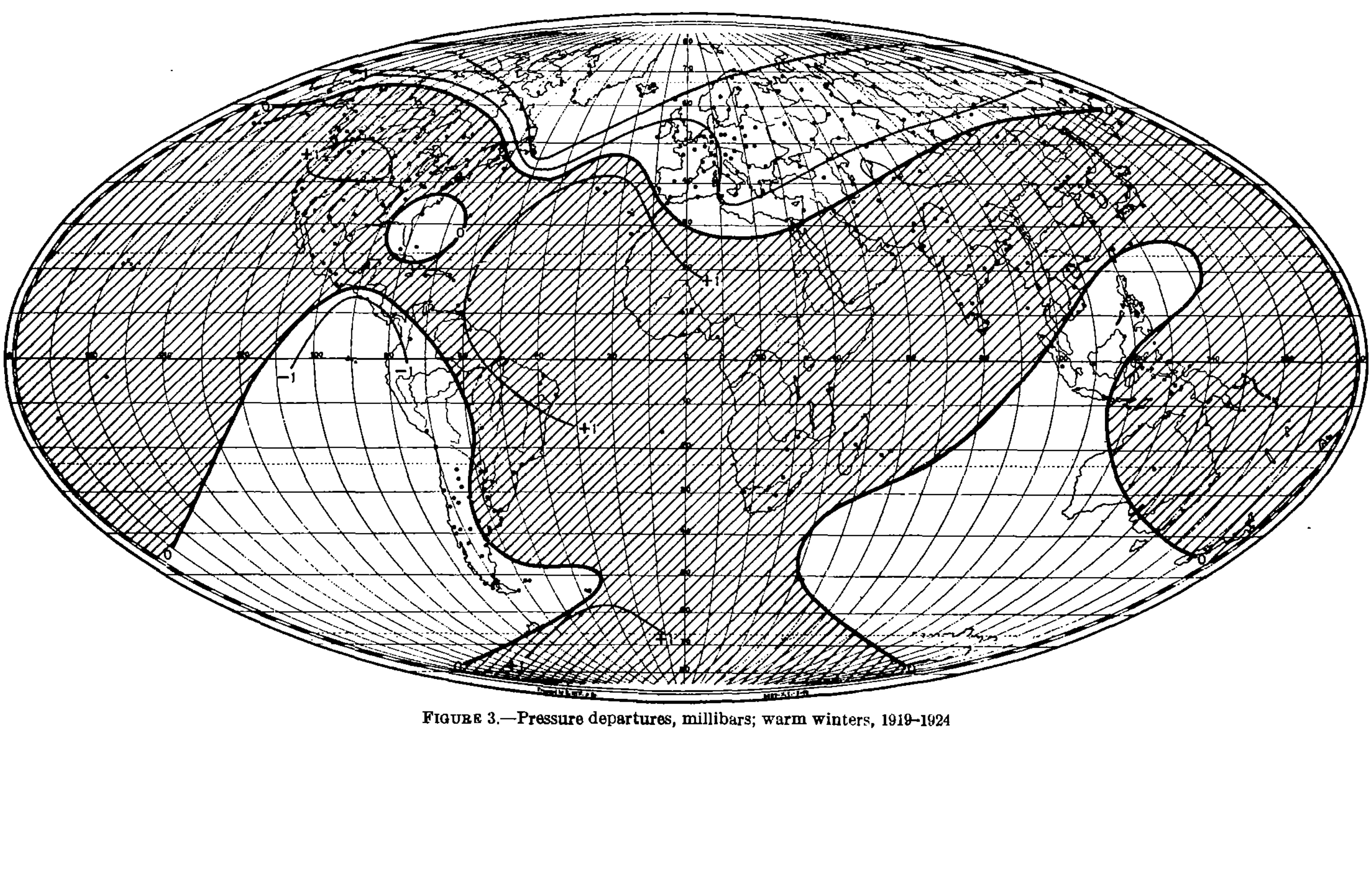

FIGURE 3.—Pressure departures, millibars; warm winters, 1919–1924

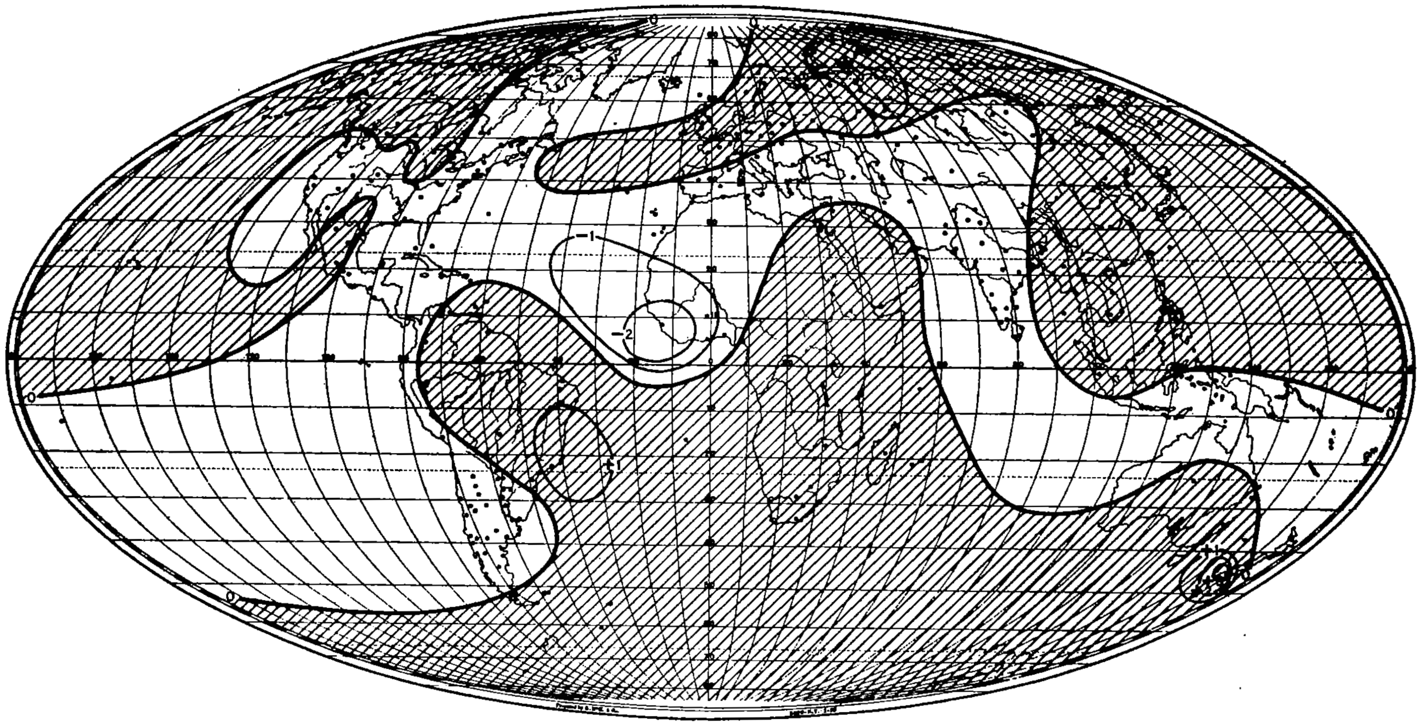

FIGURE 4.—Pressure departures, millibars; June-August, 1882-1887

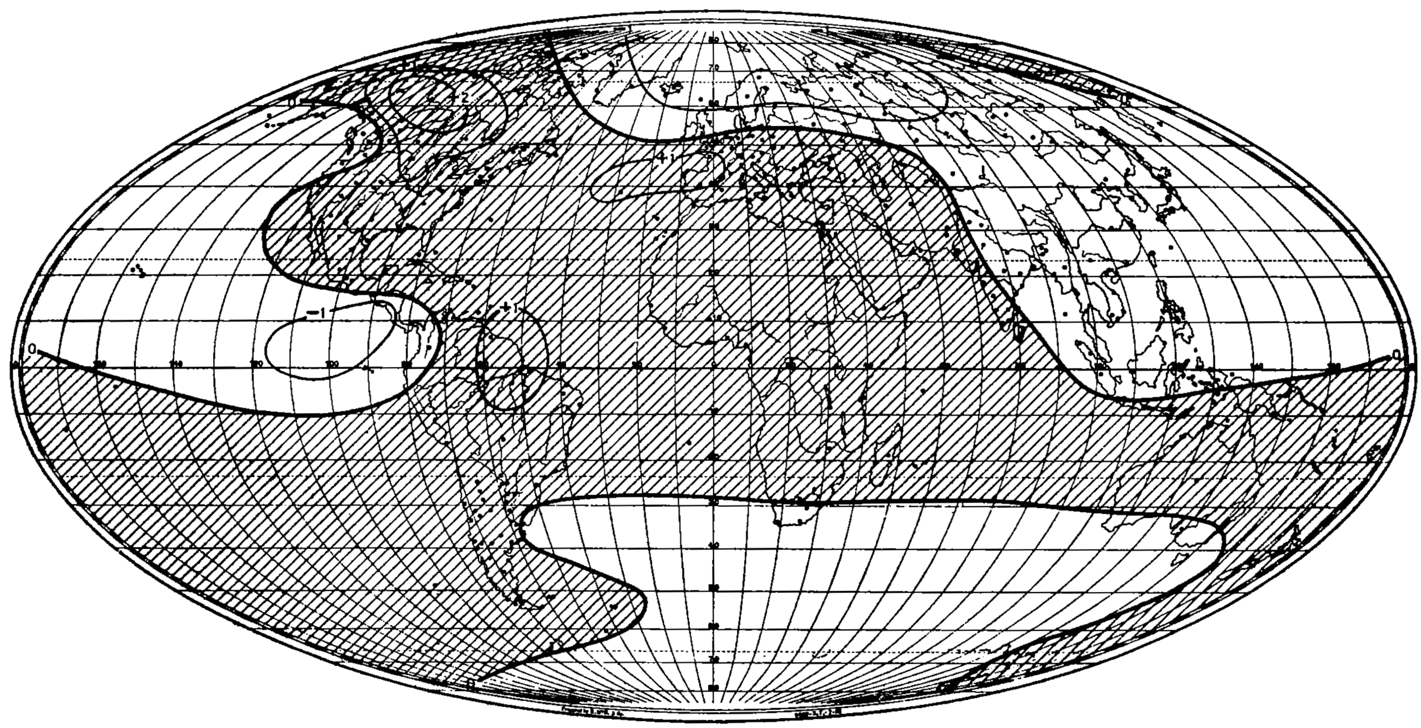

FIGURE 5.—Pressure departures, millibars; June-August, 1918-1923

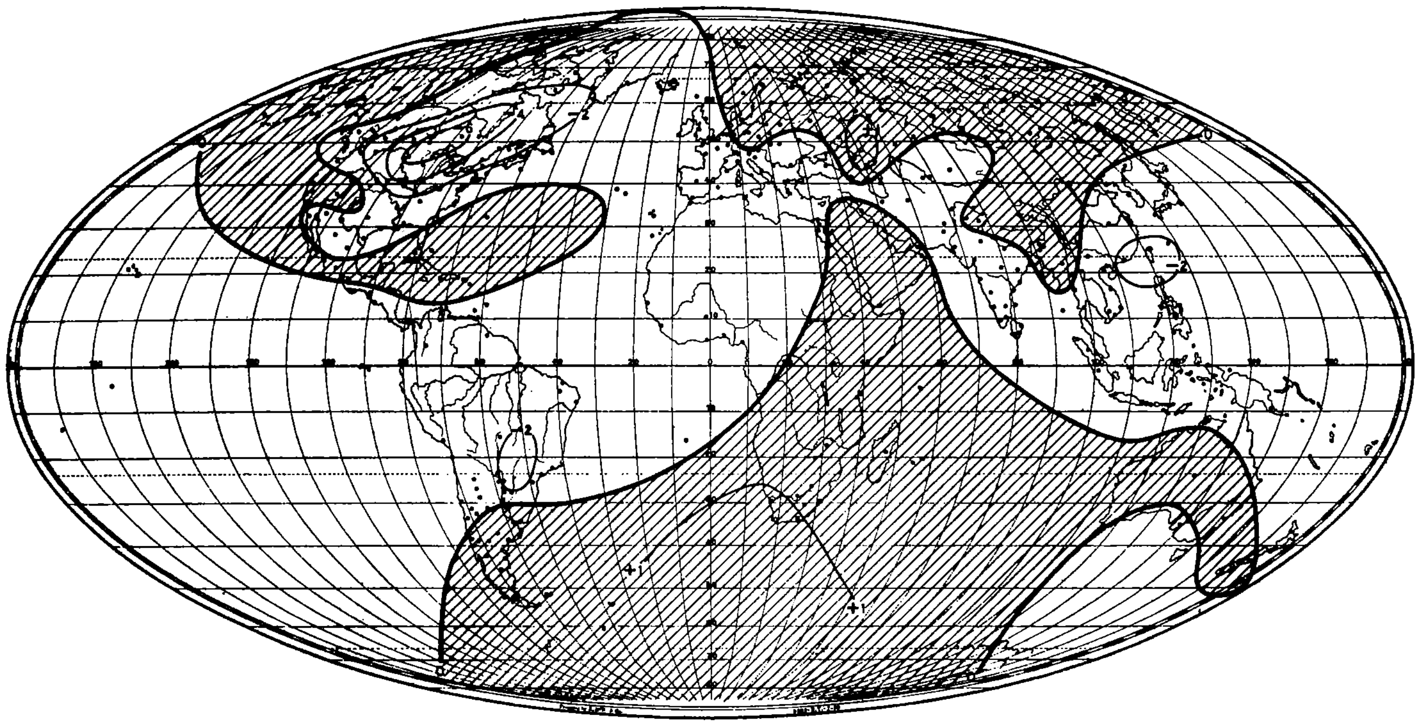

Figure 6.—Winter temperature departures; 1883-1888

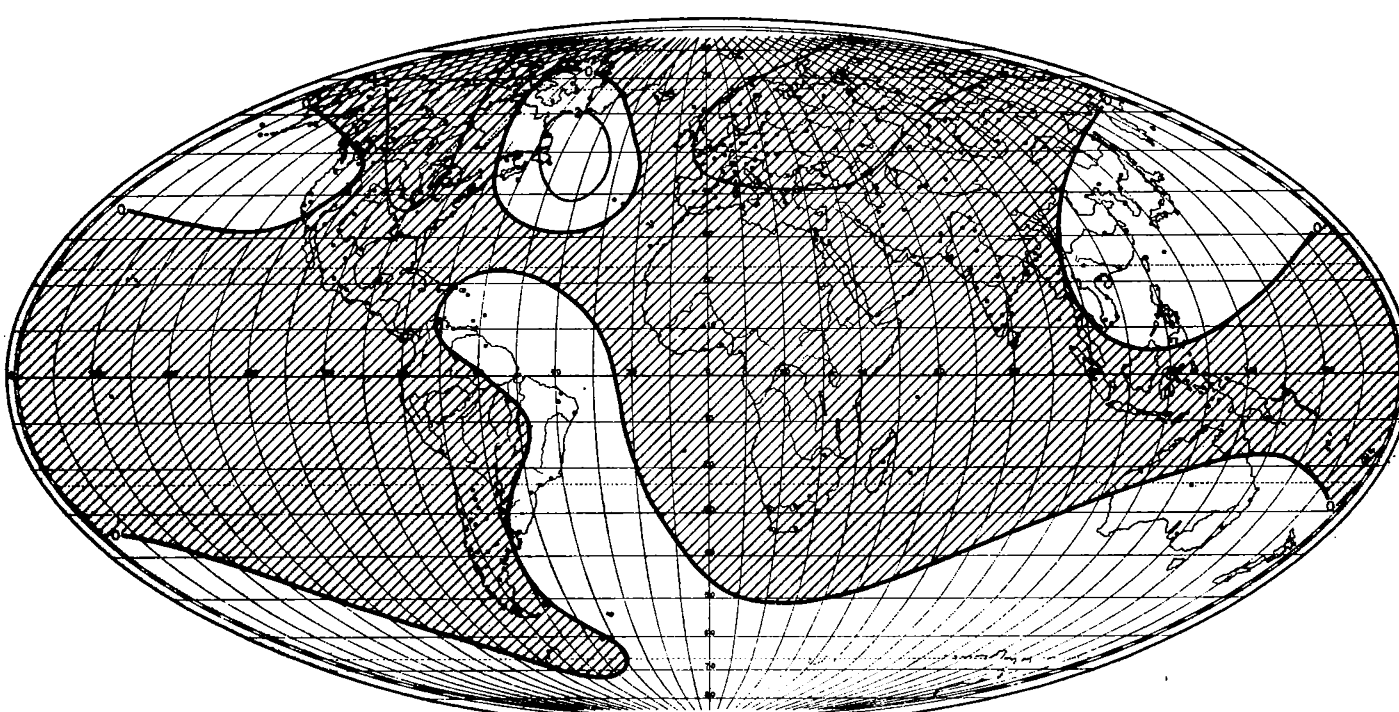

Figure 7.—Winter temperature departures; 1919-1924

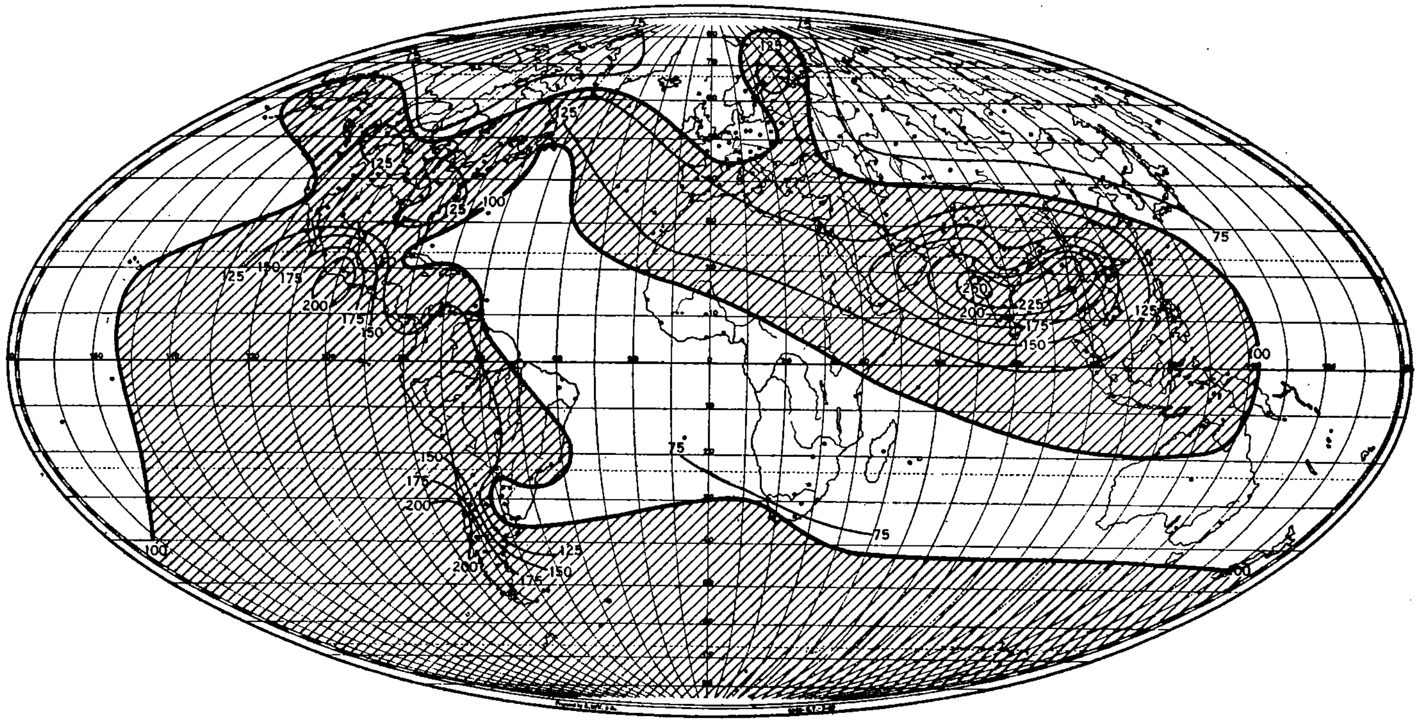

FIGURE 8.—Winter precipitation departures; percentages, 1883–1888

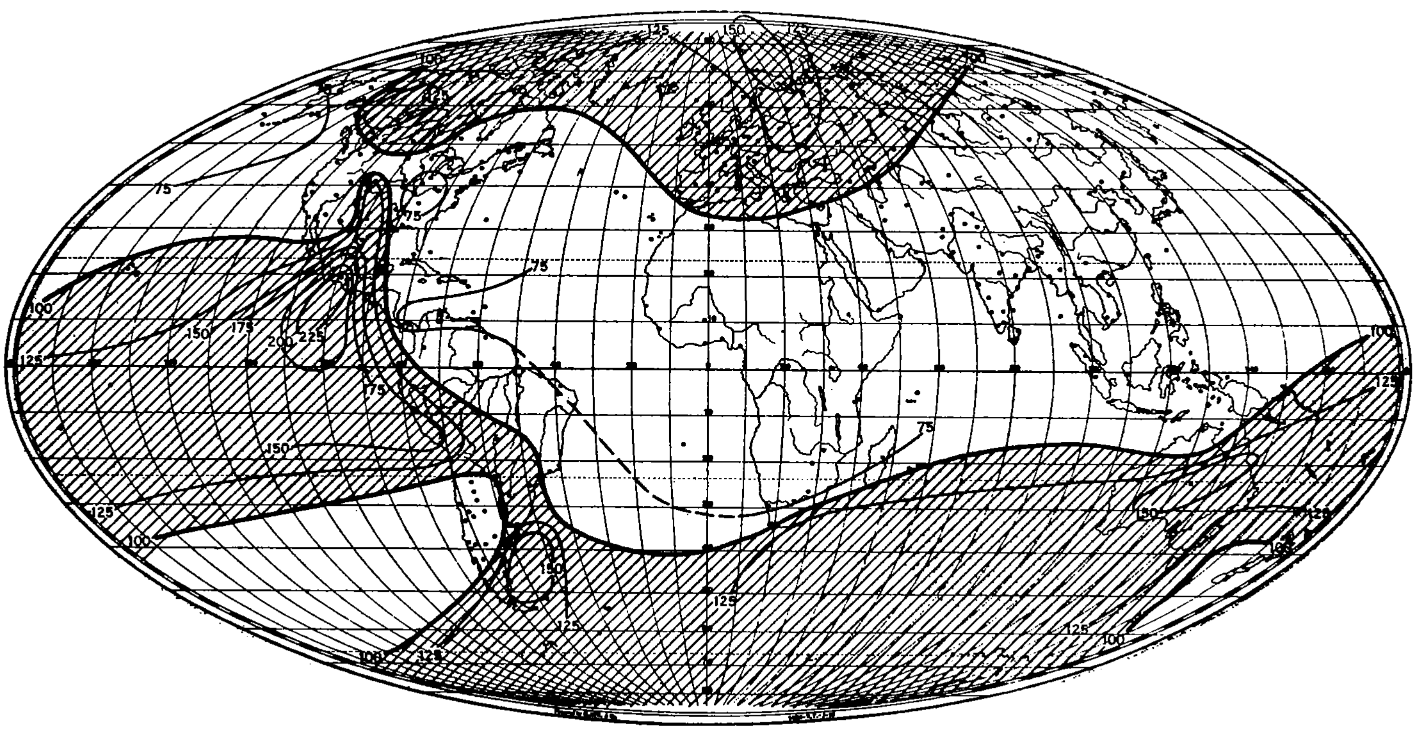

FIGURE 9.—Winter precipitation departures; percentages, 1919–1924

the difference exceeded 4° F. Also, over large areas the precipitation changed from 75 per cent of normal to 125 per cent. Significant changes in the general circulation, lasting about six years, are thus clearly shown.

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STORM WARNINGS ON THE GREAT LAKES

By GEORGE A. MARR, Vice President, Lake Carriers' Association

[Presented before the American Meteorological Society, Cleveland, Ohio, December 29–30, 1930]

Surrounded in our homes, in our offices and plants, and in every phase of our daily lives, as we are to-day, by a multiplicity of conveniences and utilities, we are prone to accept these aids and comforts as matters of course and look upon them with blasé indifference. We see them and use them with no interest beyond the comfort or convenience of the moment. The railroad, the motor car, the telegraph, the telephone, the radio, the moving picture, the iceless refrigerator, are merely things that *are*. Who stops to ponder over the research, experiment, study, labor, and organization that brought them into being or to develop them from primitive into complex and efficient instrumentalities of pleasure, usefulness, education, and better living?

This thought came home with striking force when I received the invitation to present a paper to your learned society on the subject of "Storm Warnings on the Great Lakes." I was aware that we have storm warnings, that they are indispensable to the safety of navigation, that the mariners place great dependence upon them and that we break into characteristic sailor vernacular if there is suggestion of their discontinuance before the last boat of the season is in winter quarters. And yet they have a history of development which has been obliterated from our consciousness by the long period during which the Government has performed for us this invaluable service. We have enjoyed the benefits of this service so long that we have looked upon it as complacently as you have upon the running water in your bathrooms, without thought of the engineer who designed and constructed the pumping station or the engineer who operates the pumps.

Failure of your automobile or your telephone brings dismay and harsh criticism. I can recall no instance of failure of the Weather Bureau to give advance warning of any serious storm, but it is conceivable that the results of any such failure might entail incalculable loss of life and property, and the importance of the service to safe navigation has always been regarded with the highest esteem. The Weather Bureau is entitled to the highest encomiums. No estimates can be made of the number of lives saved nor the millions of dollars worth of property preserved to transportation by their timely warnings of storms. It is no uncommon occurrence for dozens of vessels to remain in a harbor of safety in consequence of these advance notices from the Weather Bureau and I would be neglectful indeed if I failed to acknowledge, in this opportunity, the debt of gratitude which the sailor, the vessel owner, the shipper, and the traveling public owe to the faithful, devoted, and scientific service rendered by the officials and men engaged in this humanitarian calling.

The Weather Bureau was established by act of Congress in 1890 superseding a similar service inaugurated 20 years before by the War Department under a joint resolution of Congress becoming effective July 1, 1871.

Under this joint resolution of Congress, the Secretary of War was charged with the duties of taking meteorological observations and giving notice on the seacoasts and on the northern lakes by "magnetic telegraph and marine signals of the approach and force of storms." The Secretary of War was also authorized to establish signal stations at lighthouses and at such of the life-saving stations on the Lakes or seacoast as were suitably located for the purpose. Lake commerce has therefore enjoyed for 60 years a storm-warning service under the direction of either the War Department or the present organization in the Department of Agriculture.

When this service was inaugurated in 1871 the commercial traffic of the Lakes as measured by the statistics of commerce at the locks of St. Marys Falls had barely outgrown its swaddling clothes. The first lock at the Soo witnessed in its opening year, 1855, a freight traffic of less than 15,000 tons. This had grown in 1871 to nearly 600,000 tons carried in 573 steamer and 1,064 sailing ship cargoes. The commerce of the St. Marys Falls Canals now reaches a total of 100,000,000 tons in approximately 19,000 vessel passages, and the aggregate volume of the freight movement on the Great Lakes is around 150,000,000 tons carried annually in the navigation period of about seven and one-half months.

The adoption of the joint resolution of Congress establishing the storm-warning service was concurrent with the launching of the first bulk freighter on the Great Lakes. The steamer *Robt. J. Hackett*, the forerunner of the present type of ore, coal, and grain carriers, was launched in 1870. She was then the "leviathan" of the Lakes, of wooden construction, 211 feet in length and carried about 1,000 tons at the depth of water then prevailing in the connecting channels. While the type of vessel thus established has remained unchanged, the structural material has changed from wood to iron and then to steel, and the size of ships has grown to a length of 600 feet and over, with a carrying capacity sixteen-fold that of the *Hackett*. It may also be interesting to note that at the time the storm-warning service was inaugurated, sailing vessels constituted the major portion of the Great Lakes fleet. To-day there is not a sailing vessel left in the commercial trade of the upper lakes, the last one, *Our Son*, having foundered in the September storm of the past season. Incidentally this ship was built five years after the inauguration of the storm-forecasting service. Such has been the transformation of the lake fleet in 60 years. To a person not familiar with the Great Lakes the question may occur as to whether on these inland waters storms could arise of such force as to be of serious consequence to the large steel vessels of the present day. In this connection it is only necessary to refer to the storm of 1913 in which nine modern steel steamers were sunk without trace, and one, a 10,000-ton vessel loaded with coal, floated, bottom side up, on Lake Huron for several days, a striking manifestation of the power of a lake storm.